

Current state of research on the quality of meat from Polish native pig breeds

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Native pig breeds originate from local, primitive breeds. In Poland the ‘Pulawska’, ‘Zlotnicka White’ and ‘Zlotnicka Spotted’ pigs are considered native breeds. Pigs of such breeds possess many valuable traits inherited from primitive ancestors, including adaptation to local environmental conditions, feed resources and farming conditions. They are characterized by good indicators of breeding performance. Nowadays, these pigs are usually kept in individual and organic farms where they provide good fattening results even with less favourable nutrition and maintenance. Pigs of the ‘Pulawska’ breed compared to the ‘Zlotnicka’ one have a higher content of meat in the carcass, however still lower than in high-production breeds of pigs. Better slaughter value parameters can be achieved by cross-breeding of native pig breeds with conventional ones. Despite their lower meatiness, meat obtained from the native pig breeds is of good quality. Due to proper protein, water and fat content, as well as higher intramuscular fat content, meat obtained from native pig breeds is often used to produce premium quality meat products. Taking into consideration current Polish market requirements, increasing the population of native pig breeds seems challenging, but is possible in the production of traditional and regional food the popularity of which is growing.

KEYWORDS: Polish native pig breeds / ‘Pulawska’ pigs / ‘Zlotnicka White’ pigs / ‘Zlotnicka Spotted’ pigs / meat quality

Nowadays, one of the crucial goals of the pig breeding is the improvement of meat quality in order to fulfil the requirements of modern consumers. The expectations of consumers and manufactures are growing as they are looking for meat of very high quality, characterized by appropriate technological suitability. In addition, more attention is devoted to the nutritional value of the consumed meat products [Horbańczuk *et al.*

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1998, Knap *et al.* 2002, Ngapo and Gariépy 2008, Sante-Lhoutellier and Pospiech 2016, Pogorzelska-Nowicka *et al.* 2018a, Horbańczuk *et al.* 2019].

Both qualitative features and those providing technological suitability of meat and its functional value, influence consumers' decisions when choosing meat [Górska-Horczyczak *et al.* 2017, Pogorzelska -Nowicka *et al.* 2018b]. Visual factors like meat colour, fat colour, amount and distribution of fat and the amount of drip on the meat surface determine consumer preference. As the quality of fresh meat indicates its usefulness and its acceptability for cooking, it has to appear good for the customer that is selecting meat for purchase. Sensory properties, such as juiciness, tenderness, flavour and absence of off-flavours are the most important attributes comprising the sensory experience during meat consumption [Joo and Kim 2011].

The requirements of high quality and functionality can be met by meat obtained from native breed pigs. Native pig breeds come from local, primitive breeds. They were maintained in breed purity, as the breeding work was based on careful selection of individuals for mating. Pigs from native breeds possess many valuable traits inherited from primitive ancestors, including adaptation to local environmental conditions, feed resources and extensive farming conditions. They are characterized by good breeding performance – high fertility and good maternal care. They are long-living animals with a specific resistance to pathogens and stress. The products obtained from their meat are characterized by unique quality, both sensory and nutritional value [Debrećeni *et al.* 2018, Glinoubola *et al.* 2015, Mortimer and Przybylski 2016]. In Poland the following pig breeds – ‘Puławska’, ‘Złotnicka White’ and ‘Złotnicka Spotted’ are concerned as native breeds. These breeds are protected by the Conservation of Genetic Resources of Farm Animals program as an essential component of biodiversity that fits in with the goals of sustainable development and production [Prasow *et al.* 2018].

It should be underlined that the present in the world and in Europe trend of intensifying breeding is common. However, also extensification of pig production systems is imposed in Europe by the EU. The extensive systems require breeds that are adapted to local conditions. For example, in Hungary a protection program concerns a native breed Mangalica. In Scandinavia extensive breeds pigs account is about 1/3 of the market and this share is growing. The EU supports programs for of native genetic resources protection, providing financial support for example to France for the Gascone breed or Italy for the protection of the Casertana or Calabrese breed.

‘Puławska’ pig breed

‘Puławska’ pig breed is considered to be the oldest Polish native breed of pigs, which origins reach the beginnings of the 20th century [Szyndler- Nędza *et al.* 2017]. In the sixties of the last century, a decrease in the population of ‘Puławska’ pigs in Poland was noted due to increase in the demand for pigs in the meat type and pigs of white breeds. At the turn of the 1980s and 1990s, it was decided to preserve the ‘Puławska’ breed and rebuild its population [Debrećeni *et al.* 2018]. Currently, pigs of the ‘Puławska’ breed are in the transitional between fatty-meat and meat type.

Due to good breeding performance and numerous advantageous traits described as maternal properties, those pigs are often used as a mother component during cross-breeding [Milczarek 2016, Wojtyasiak *et al.* 2014].

Pigs of the ‘Puławska’ breed compared to the ‘Złotnicka’ breeding pigs have higher content of meat in the carcass (Tab. 1). However, it is still lower than in breeds of pigs used in intensive production systems, like ‘Polish Large White’ or ‘Polish Landrace’ [Buczyński *et al.* 2012, Florowski *et al.* 2006, Grześkowiak *et al.* 2005, Grześkowiak *et al.* 2009, Strzelecki *et al.* 2006]. Research performed by Florowski *et al.* [2008] and Kasprzyk *et al.* [2013] showed a slightly higher carcass fat content in the hybrid of ‘Puławska’, ‘Polish Large White’ and ‘Polish Landrace’ pigs compared to pure-bred pig carcasses, however these differences were not statistically significant.

On the other hand, the cross-breeding of ‘Puławska’ pigs with ‘Polish Large White’ and ‘Polish Landrace’ pigs had a significant impact on many important parameters of meat quality. The most favourable quality of meat for human consumption has been reported for the hybrid of ‘Puławska’ and ‘Polish Landrace’ pigs. This meat had a typical pH after 45 min and 24 h *post mortem*,

little drip loss, good water holding capacity, higher protein content and lower collagen and intramuscular fat content (although not lower than 1%) (Tab. 2). Such meat was highly positively evaluated during sensory evaluation. It can be used to produce dry cured hams of high quality [Florowski *et al.* 2008]. Good sensory quality of ‘Puławska’ pork meat was confirmed in a study conducted by Kasprzyk *et al.* [2010], where it obtained the highest scores of juiciness and together with the meat from crossbreeds of ‘Puławska’ and (‘Hampshire’ x wild boar) was distinguished by higher sensory quality compared to meat of the wild boar.

Table 1. Slaughter value of Polish native pig breeds fatteners

Breed	Slaughter weight (kg)	Hot carcass weight (kg)	Cold carcass weight (kg)	Meatiness (%)	Backfat thickness (mm)	Loin eye area (mm ²)	Reference
‘Puławska’	102.0	81.9	80.3	-	31.0	37.9	Debrečeni <i>et al.</i> [2018]
	122.0	-	92.05	52.96	-	-	Litwińczuk <i>et al.</i> [2018]
	100.0	76.34	-	45.30	23.64	43.28	Wojtyasiak and Poltowicz [2014]
	100.0	79.32	-	55.47	16.9	-	Kasprzyk <i>et al.</i> [2013]
‘Złotnicka’	80.0	-	-	-	20.0	33.7	Babicz <i>et al.</i> [2010]
	100.0	-	-	52.0	27.0	39.8	Florowski <i>et al.</i> [2006a]
‘Złotnicka’ White’	105.0	80.17	-	46.33	34.73	36.20	Grześkowiak <i>et al.</i> [2007]
	105.0	80.17	-	46.33	34.73	36.20	Grześkowiak <i>et al.</i> [2006]
‘Złotnicka’ Spotted’	120.0	82.11	-	-	25.62	-	Domański <i>et al.</i> [1996]
	103.3	82.7	81.4	-	29.0	37.8	Debrečeni <i>et al.</i> [2018]
	107.12	-	79.66	-	29.49	33.60	Buczyński <i>et al.</i> [2012]
	119.20	-	93.0	41.83	34.96	-	Szule <i>et al.</i> [2012b]
‘Złotnicka’ Spotted’	106.0	-	79.39	-	29.62	33.54	Jankowiak <i>et al.</i> [2010a]
	105.0	78.32	-	46.28	32.11	37.45	Grześkowiak <i>et al.</i> [2007]
	97.32	78.18	-	44.69	31.30	33.97	Kapelański <i>et al.</i> [2006]

Table 2. Selected physical and chemical parameters of meat (samples from *Longissimus* muscle) obtained from 'Pulawska', 'Zlotnicka White' and 'Zlotnicka Spotted' pigs

Breed	pH ₁	pH ₂	Drip loss (%)	WHC	L*	a*	b*	Water (%)	Protein (%)	Fat (%)	IMF (%)	Water to protein ratio	Reference
'Pulawska'	6.50	5.60	4.70	-	52.10	3.10	16.10	69.80	23.30	-	5.50	3.00	Debrečeni <i>et al.</i> [2018]
	6.46	5.97	-	-	54.66	17.87	6.24	73.01	23.59	-	2.66	3.09	Litwiczuk <i>et al.</i> [2018]
	6.78	5.63	1.75	18.31	47.16	14.36	3.39	-	-	-	3.33	-	Wojtylak and Poltowicz [2014]
	6.38	5.67	4.20	20.03	48.75	16.99	5.04	73.99	22.40	-	2.20	3.30	Kasprzyk <i>et al.</i> 2013
	6.11	5.58	2.18	21.03	53.17	13.29	2.02	72.81	22.95	3.00	-	3.17	Milezarek and Osek [2016]
	6.10	5.57	-	22.73	-	-	-	-	-	-	1.62	-	Babicz <i>et al.</i> [2010]
'Zlotnicka White'	6.43	-	-	170.0	50.68	8.71	1.26	73.70	22.40	2.50	-	3.29	Florowski <i>et al.</i> [2006b]
	6.38	5.53	3.36	-	43.88	6.27	4.95	72.40	24.50	1.87	-	2.96	Grześkowiak <i>et al.</i> [2009]
	6.38	5.38	3.36	29.88	40.88	-	-	72.40	24.50	1.87	-	2.96	Grześkowiak <i>et al.</i> [2006]
'Zlotnicka Spotted'	6.34	5.66	-	-	-	-	-	-	-	-	-	-	Domański <i>et al.</i> 1996]
	6.40	5.60	2.90	-	49.20	2.70	17.80	70.50	25.20	-	2.60	2.80	Debrečeni <i>et al.</i> [2018]
	6.33	-	2.55	16.51	49.30	17.34	3.74	-	-	-	-	-	Bocian <i>et al.</i> 2012]
	6.15	5.42	-	-	50.46	4.06	7.89	-	-	-	-	-	Szulec <i>et al.</i> [2012b]
	6.39	5.50	2.36	32.66	46.43	8.17	2.89	71.74	24.54	3.44	-	2.92	Szulec <i>et al.</i> 2012a]
	6.34	-	2.53	16.48	49.28	-	-	-	-	-	1.87	-	Jankowiak <i>et al.</i> [2010a]
6.39	5.51	2.44	-	48.54	17.08	2.49	73.64	22.79	-	2.17	3.23	Jankowiak <i>et al.</i> [2010b]	
6.32	5.56	3.41	-	47.97	4.73	5.01	73.53	23.27	2.04	-	3.16	Grześkowiak <i>et al.</i> [2007]	

pH₁ – pH 45 min *post mortem*; pH₂ – pH 24 h *post mortem*; WHC - water holding capacity; IMF – intramuscular fat.

The loin eye area in the 'Puławska' pigs ranged from 33.7 to 43.28 mm² (Tab. 2). It was slightly smaller (48.5 mm²) than in the results obtained by Florowski *et al.* [2008]. In these studies, there was no significant impact of crossing 'Puławska' pigs with 'Polish Landrace' and 'Polish Large White' pigs on this parameter. On the other hand, Babicz *et al.* [2010] showed that loin eye area in the fatteners of the 'Puławska' pigs was on average 2.3 mm² larger than in the hybrid of 'Puławska' x ('Hampshire' x boar), and these differences were statistically significant.

A study conducted by Florowski *et al.* [2008] also showed that the meat of 'Puławska' pigs compared to the meat of 'Polish Landrace' pigs was characterized by a significantly smaller drip loss (3.7 as compared to 5.1%) and significantly lower cooking losses (4.8 as compared to 8.6%). The brightness of the meat from the 'Puławska' pigs was similar to the brightness of the meat from the 'Złotnicka Spotted' pigs, however it was significantly higher than the brightness of the meat from the 'Złotnicka White' pigs (Tab. 2).

The meat obtained from the 'Puławska' pigs was characterized by a slightly higher water content and a lower protein content compared to the 'Złotnicka' breeding pigs (Tab. 2), however such parameters were significantly more favourable than in meat obtained from the 'Polish Landrace' pigs. Moreover, Florowski *et al.* [2008] showed that the intramuscular fat content (IMF) reached 2.5%, thus was optimal for the sensory assessment of the tenderness and juiciness of meat. Such IMF content was significantly higher than in the meat of the 'Polish Landrace' pigs (1.3%) and significantly lower than in the meat of 'Złotnicka Spotted' pigs (3.1%). Slightly lower intramuscular fat content (2.17%) was recorded by Tyra and Żak [2010]. In the meat derived from the 'Puławska' and 'Polish Landrace' crossbred pigs, a significantly higher level of unsaturated fatty acids, mainly monounsaturated fatty acids was recorded as compared to meat obtained from the hybrid pigs 'Naïma x P-76'. On the other hand, in the meat from the hybrid pigs, the level of C18:2 linolenic acids and C18:3 linolenic acid was higher than in the meat of crossbred pigs with the participation of the 'Puławska' breed [Grzeškowiak *et al.* 2005].

'Złotnicka' pig breeds

The origins of the 'Złotnicka' pig breed in Poland are dated around 1946, when prof. Stefan Alexandrowicz conducted monographic studies on the primitive hybrid pigs reared in the Olsztyn province. As a result of a rationally conducted selection and proper mating, two varieties of 'Złotnicka' pigs were developed - White in the meat type and 'Spotted' in the meat-bacon type. In 1962 these varieties were recognized as separate breeds.

'Złotnicka White' pig breed

The meatiness of the 'Złotnicka White' fatteners has been reported as of 46.33 % (Tab. 1). Significantly higher meatiness, lower fatness and a larger loin eye area were noted in the hybrids of 'Złotnicka White' and 'Polish Large White' pigs. Such carcasses

also had a higher percentage share of pork, shoulder and neck [Grześkowiak *et al.* 2005, Strzelecki *et al.* 2006]. However, in purebred carcasses of 'Złotnicka White' pigs, a higher, more favourable percentage share of ham, loin and shoulder was noted compared to the carcasses of 'Złotnicka Spotted' pigs [Grześkowiak *et al.* 2009].

The meat obtained from the 'Złotnicka White' pigs was characterized by a higher drip loss as compared to the meat obtained from the 'Złotnicka Spotted' pigs (Tab. 2). A slightly smaller drip loss (3.16 compared to 3.36%) was observed in meat of 'Złotnicka White' and 'Polish Large White' crossbreed pigs [Grześkowiak *et al.* 2009]. In studies performed by Grześkowiak *et al.* [2009], statistically significant differences were found between meat obtained from the pigs of 'Złotnicka White' and 'Spotted' breed. They were related to the content of water and protein, water absorption and brightness, which were more beneficial in the meat of 'Złotnicka White' pigs (Tab. 2). Cooking loss was also significantly lower in this meat. The fatty acid profile in meat of both 'Złotnicka' breeds was similar. Observed differences were related to the lower content (by 2.05%) of monounsaturated fatty acids and higher content of polyunsaturated fatty acids (by 1.87%) in 'Złotnicka White' pigs meat [Grześkowiak *et al.* 2009].

Good sensory quality of 'Złotnicka White' and 'Złotnicka Spotted' pork meat was confirmed by Grześkowiak *et al.* [2009]. The cooked loin produced from meat of 'Złotnicka Spotted' pigs was distinguished by slightly higher sensory quality as compared to the meat of 'Złotnicka White' pigs, while raw smoked loin produced from meat of 'Złotnicka White' pigs reached was rated higher.

'Złotnicka Spotted' pig breed

The breeding of 'Złotnicka Spotted' pigs, as the only one in Poland, has been conducted without the genepool addition from other breeds. Currently, these are pigs in the meat-bacon type towards the meat type [Prasow *et al.* 2018].

Carcasses of 'Złotnicka Spotted' pigs had the smallest meat content compared to other native pig breeds (Tab. 1). In the studies of Grześkowiak *et al.* [2009], the carcasses of the 'Złotnicka Spotted' pigs had significantly lower backfat thickness than the 'Złotnicka White' pigs, however, the meat content in both breeds was similar at around 46 %. Slightly higher meat content in 'Złotnicka Spotted' carcasses was reported by Szulc *et al.* [2006], who studied the meatiness of the carcass in vivo. The increase of meat content in the carcass and reduction of its fatness can be achieved by crossing 'Złotnicka Spotted' pigs with high-meatiness breeds, e.g. 'Hampshire' and 'Pietrain' [Nowachowicz 2005, Szulc *et al.* 2006].

Good results - an increase in meatiness by 1-4%, a reduction in fatness and a significant increase in the loin eye area (from 5.63 to 6.36 cm²) were obtained due to crossbreeding of the 'Złotnicka Spotted' with 'Polish Large White' and 'Duroc' pigs [Szulc *et al.* 2011]. Buczyński *et al.* [2012] indicated a significant increase in meatiness and a decrease in fatness in crossbreeds of the 'Złotnicka Spotted' sows with 'Duroc' boars. On the other hand, studied by Jankowiak *et al.* [2010a] fatteners of the 'Złotnicka Spotted' breed were characterized by greater fatness and smaller loin

eye area compared to the 'Polish Large White' and 'Polish Landrace' crossbreeds, and such differences were highly significant. A similar value of the loin eye area were reported by Kapelański *et al.* [2006]. Slightly higher backfat thickness and a larger loin eye area was also noted [Grzeškowiak *et al.* 2009].

Despite its lower meatiness, meat obtained from the 'Złotnicka Spotted' is of good quality and can be used to produce good quality meat products [Kapelański *et al.* 2006]. Many authors suggest that these late maturing pigs due to the good mast results achieved at high body weights can be used to produce heavy fatteners. The meat obtained from them can be then used to produce traditional raw, ripening hams and loins, which are treated as the local products associated with a given region or country [Janiszewski *et al.* 2015; Jankowiak *et al.* 2010a, Kapelański *et al.* 2006]. No or a very small percentage of defects like PSE meat were detected in the meat of 'Złotnicka Spotted' pigs, which is probably due to the small burden of these pigs with the *RYRI* gene responsible for the occurrence of this defect and can be the result of an adverse impact of periosteal factors, like electrical stunning [Jankowiak *et al.* 2010b, Kapelański *et al.* 2006]. This meat was also characterized by small drip loss, good water holding capacity (significantly higher than the meat of 'Polish Landrace' or 'Puławska' pigs), as well as small losses during cooking (Tab. 2). The meat of 'Złotnicka Spotted' pigs compared to the crossbreds of 'Polish Landrace' and 'Polish Large White' pig's meat had significantly lower drip loss, was darker, with more desirable color and higher pH after 48 h after slaughter and significantly higher red colour (a*) with a significantly smaller yellow colour (b*) [Bocian *et al.* 2012]. The average intramuscular fat content reported by Jankowiak *et al.* [2010a] of 1.87%, was slightly lower than the values considered optimal [Tyra and Żak 2010]. In the studies of Jankowiak *et al.* [2010a], no relationship between fat in the carcass of 'Złotnicka Spotted' pigs and the content of intramuscular fat in meat was found. While investigating the fatty acid profile, it was noted that the palmitic acid content was significantly lower as compared to the crossbreds of the 'Polish Landrace' and 'Polish Large White' pigs [Jankowiak *et al.* 2010a]. Meat of good quality was also obtained from crossbred of 'Złotnicka Spotted' with 'Polish Large White' and 'Duroc' pigs [Szulc *et al.* 2012a, Szulc *et al.* 2012b].

Lower meatiness of native pig breeds contributed to a dramatic reduction in their populations in the 1980s and 1990s. Since the 'Puławska', 'Złotnicka White' and 'Złotnicka Spotted' pigs had been protected by the Conservation of Genetic Resources of Farm Animals program, further decline of their population has been stopped and a partial rebuilding of their population has started. These pigs are usually kept in family and organic farms where they achieve good fattening results, even in less favourable nutrition and maintenance. Taking into consideration current market requirements, increasing the population of native pig breeds seems difficult, but the chances for their further development are seen in the production of traditional food which popularity is growing. Due to the very good meat quality and higher intramuscular fat content, pigs of native breeds are more often used in the production of traditional and regional meat

products. Meat of 'Puławska', 'Złotnicka White' and 'Złotnicka Spotted' pigs as well as roast leg of 'Złotnicka White' pigs have been included in the List of Traditional Products run by the Ministry of Agriculture and Rural Development. Currently, there is a gap in research linking sensory quality with nourishing value of meat products obtained from native pig breeds.

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